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(71) Applicant: CHIRON VISION CORPORATION [US/US]; 555 West Arrow Highway, Claremont, CA 91711 (US).

(72) Inventors: STEEN, Mark, E.; 16044 Medlar Lane, Chino Hill, CA 91709 (US). YONEMOTO, Jay, A.; 17800 E. Colima Road #281, Rowland Heights, CA 91748 (US). FLORES, Ernesto, E.; 3752 Cosley Street, Irvine, CA 92704 (US).

(74) Agents: WISE, Roger, R. et al.; Cushman Darby and Cushman, Intellectual Property Group of Pillsbury Madison & Sutro, 1100 New York Avenue, N.W., Washington, DC 20005 (US).

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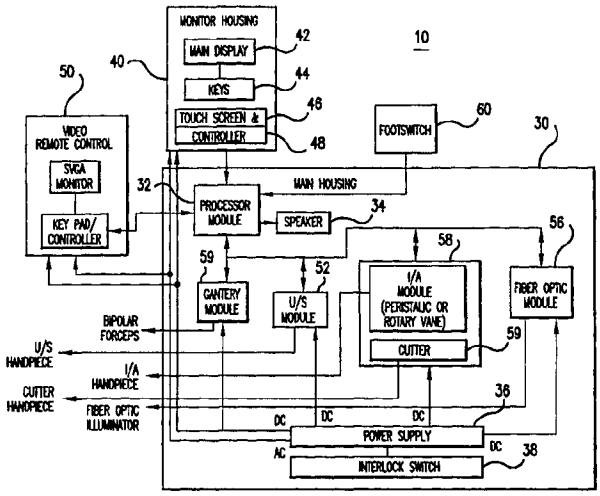

(57) Abstract

A remote control unit for use with an ophthalmic surgical control system has full function push button switches and a display screen. The remote control unit is connected to the surgical control system via a communication cable. The remote control unit includes a microprocessor to receive information from and send information to the control system. The push button switches allow the remote control unit to select surgical modes, such as cauterization, phacoemulsification, irrigation/aspiration, vitrectomy and illumination, and allow controlling of mode parameters. The display screen is operator-selected to display either mode function parameters or a video feed from a surgical site to observe the surgical procedures performed by a surgeon.

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REMOTE CONTROL FOR OPHTHALMIC SURGICAL CONTROL CONSOLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of ophthalmic surgery, and in particular to a remote control device for a surgical control console.

2. Description of Related Art

Microsurgical systems, including a plurality of related surgical modules and instruments, are known for performing precise microsurgical procedures in the field of ophthalmology, and have been widely used for performing anterior as well as posterior chamber surgery.

In either type of surgery, a remote hand piece having a small surgical instrument is used to cut, emulsify or cauterize the eye tissue while an irrigation or infusion liquid is brought to the site of the surgery. The cut or emulsified tissue is carried away from the surgical site by aspiration through a suction conduit or tube to a collection vessel such as a bag or bottle located at a remote location from the instrument.

The operation of the various microsurgical tools, including the suction produced in the suction conduit is usually controlled by a surgeon via various combinations of hand switches and foot switches so that operation of the tools can be controlled during surgery, and that infusion/aspiration can be regulated during the surgery without removing the instrument from the site of the surgery.

In a typical ophthalmic operation, a surgeon often has the assistance of a scrub nurse, a circulating nurse, and as appropriate other personnel as well. The surgeon typically spends considerable time peering through a microscope to obtain a magnified view of the eye being operated on. Thus, the surgeon often requests assistance from the nursing staff for various

tasks, such as changing pressures, power levels, cut rates, irrigation rates and control modes of the equipment. Under some circumstances, such as a cataract operation, where an emergency vitrectomy may need to be performed, the surgeon might well be involved in completing one task, such as a phacoemulsification procedure, while the other members of the surgical team are required to set up for a different surgical procedure, such as vitrectomy.

To facilitate the operation of the equipment by both the surgeon and the assisting nurses, some systems employ both a main control console and a remote control. A conventional remote control system used with a surgical control system typically has only some of the control capabilities for various surgical devices to assist ophthalmic surgery. Thus, one common problem with many conventional remote controls is that it may not have the full control capability available at the main surgical control console. As a consequence, the surgical assistant often must use the main surgical control console to control those surgical devices or functions not controllable from the remote control.

In order to effectively assist the surgeon, the nurse operating the controls should monitor the progress of the surgery by viewing the surgical site. However, because of the bright lights needed for the surgery, it is often difficult for the assisting nurse to alternately view both the surgical site and the controls necessary for the surgical procedure.

SUMMARY OF THE DISCLOSURE

It is an object of the present invention to provide a remote control device obviating for practical purposes the above mentioned limitations, particularly in a manner requiring a relatively uncomplicated mechanical arrangement.

According to one aspect of the invention, the remote control device is for use with a surgical control console responsive to user-selected control parameters for controlling surgical procedures. The remote control device may also be used with a viewing device, such as a video camera, adapted to view a surgical site. The remote control device has a plurality of switches and a display apparatus housed in a portable enclosure and is coupled to the control module for selecting surgical control parameters; a user-operated display switch for selecting for display at least one of the camera views of the surgical site and selected surgical control parameters of the control console; and a display apparatus for showing the view selected by the user-operated display switch. The display apparatus displays surgical mode icons in which each surgical mode is selectable with one of the plurality of switches. The plurality of switches arranged around the display apparatus includes a first group of switches for selecting surgical modes, a second group of switches for selecting surgical support functions, and a third group of switches for adjusting operating parameters.

The remote control device further includes a multiplexer responsive to the user-operated display switch for selecting for display at least one of the camera views of the surgical site and the selected surgical control parameters of the control console.

These and other aspects, features and advantages of the present invention will be better understood by studying the detailed description in conjunction with the drawings and the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of embodiments of the invention will be made with reference to the accompanying drawings, wherein like numerals designate corresponding parts in the several figures.

FIG. 1 is a perspective view of the control console and visual display system of the microsurgical system for performing ophthalmic surgery.

FIG. 2 is a system block diagram illustrating the various subsystems (hardware modules) comprising the microsurgical system;

FIG. 3 is a block diagram of the remote control unit according to a preferred embodiment of the present invention;

FIG. 4 is a block diagram of a second embodiment of the remote control unit;

FIG. 5 is a perspective view of the remote control unit showing one of the surgical modes; and

FIG. 6 is the remote control unit showing the surgical site.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A remote control device for an ophthalmic surgical control console according to an embodiment of the invention is shown in the drawings for purposes of illustration. The remote control device is a full functioned wired system designed to be used with an ophthalmic surgical control console. A preferred embodiment of the remote control device has a full color display for displaying operating parameters, including the status of the surgical control console in graphic format. The remote control device also has the ability to switch between system function display and the video feed from a surgical microscope having a video camera so that a surgical assistant has access to the surgeon's view of the surgical site from the remote control device to provide effective assistance during surgical procedures.

Fig. 1 illustrates a microsurgical system 10 which has a main console 14 for housing various hardware modules necessary for ophthalmic surgery. The main console 14 is controlled by the main control system 12 and the remote control unit 16. The main control system 12 is mounted on a base 13 attached on the surface of the main console 14. The remote control device 16 is connected to the main console 14 via a communication cable 18 which provides bidirectional communication to and from the main console 14. The remote control unit 16 is typically used by surgical support staffs (e.g., nurses) to assist a surgeon during ophthalmic surgery. The remote control unit 16 provides the support staff or an operator with a straightforward means of invoking all of the different modes, the functions under each mode, and a way to adjust the various set-up and operating parameters associated with various electronic control circuits and pneumatic control systems. As shown in Fig. 1, there are multipin connectors 22, 24, 26 and 27 which are provided on the front surface of the main console 14 to enable quick and convenient handpiece connection to

the hardware modules intended for use in the system 10, which will be discussed below.

Fig. 2 illustrates a system block diagram of the microsurgical system 10. The system 10 contains the necessary components (hardware modules) housed in the main console 30 to provide, for example, phacoemulsification ("phaco"), indicated as module 52; bipolar coagulation ("bipolar"), indicated as module 54; fiber optic illumination ("fiber optics"), indicated as module 56; cutting ("cutter"), indicated as module 59; and infusion, vacuum and aspiration ("I/A pumps"), indicated as module 58. As shown in Fig. 2, each hardware module interfaces with a processor module 32 and has remote control capabilities. A main display 42 and push button keys 44 functions as the primary input/output ("I/O") device for the system and provides the means to select and set user preferences and selections. In addition, user input may be implemented by both a touch screen 46, which preferably is an ELOGRAPHICS® touchscreen with touchscreen controller 48 overlaid onto the main display 42, and, a remote control unit 50 for communication with the main control console 30.

The processor module 32 of the microsurgical system 10 has a microprocessor and suitable ROM/RAM memory for controlling the individual modules as well as the entire system 10. A X86-based microprocessor is provided in the processor module 32 of system 10 with memory and I/O capabilities necessary to send and receive commands to the bipolar, phaco (ultrasonic), cutter, fiber optics, I/A pumps, remote control unit, and foot switch modules to enable real time monitoring and control thereof. The multi-tasking operating system provides the immediate processing of input to provide optimum performance of each hardware module as well as the overall system. Connected to the processor module 32 is a speaker 34 for emitting audio and digitized voice signals and a foot switch controller 60 which may comprise a modified type (e.g., Catalyst™) footswitch. The processor module 32 contains the necessary interfaces and

serial communication channels for the footswitch 60 and the remote control unit 50. The processor module 32 also provides both digital and analog input and output capability to communicate with other modules and external devices. For example, eight channels of analog output are provided by using two quad digital to analog converters and eight channels of analog input are provided by an analog multiplexer (not shown) and an analog to digital converter (not shown).

The system 10 additionally includes a power supply module 36 that is provided for connection to a standard a.c. power source for powering the system. The power supply module 36 is provided with a main power on/off switch and interlock circuitry 38 and functions to convert the main (line) voltage to appropriate DC voltages for powering all other modules in the system, including the remote control unit 50.

Since the microsurgical system 10 is computer driven, it offers a surgeon the option of programming surgical machine operational settings and indicators (e.g. bipolar power, aspiration flow rate, phaco power settings, etc.) into the computer's memory to eliminate the need for an operator to know and manually change these machine settings each time the system 10 is used. The processor module 32 contains the software which is used to control the system and also to generate a graphical user interface (GUI) for displays on the main control system 40 and the remote control unit 50. Specifically, it is the microprocessor in conjunction with series of bitmap files that actually draws indicators on the main display 42 and then interprets the touch points on the transparent touch screen overlay 46. Since the computer determines the exact position of every graphic object it displays, the touch points are translated by system software to specific display screen coordinates. The processor module 32 then correlates the touch points to the graphic objects displayed at those coordinates. The main display 42 is designed to look like a control panel with bar graph displays indicating both preset user preferences and actual parameters. Both preset

and actual values will each have separate displays. The mode parameters (such as vacuum, flow rate, power, etc.) can be set using Up/Down keys on the bezel of the display. The mode parameters that are adjusted are displayed adjacent to the keys. Due to the multitasking operating system, the graphs dynamically change as the changes occur in real time, just as conventional controls respond. The main display 42 is provided with on-screen graphic capability for displaying graphics objects, such as push buttons, icons, slide bars, etc., representing various functions and parameters. In a preferred embodiment, the microsurgical system 10 has a main display screen with a preferred minimum resolution of 640 x 480 pixels by 16 colors with RGB component control.

Other controls on the main control system 40 act like push buttons and repeated touching of a push button icon will cause the computer to turn that particular function on or off, in the same way as a physical switch, by supplying or removing power to the circuit. When touched, the appearance of the button image, or icon, will change to show the selection. The icons displayed on the main display 42 graphically represent their associated functions. For example, to select a surgical mode, touching one of the surgical mode icons will select that mode. The Cautery Module icon 164a as shown in Fig. 5, is displayed as a set of forceps between the tips, which represents the high voltage known to cause cauterization.

The main display 42 preferably shows only the controls needed for the user's currently selected surgical mode. However, certain surgical support functions are available in all modes. As the user selects operating modes, the touch screen main display 42 changes to show the menus and status corresponding to the selections. For instance, the selected icon will change in color, action, etc. to show the change in status. If there are graphs or indicators for the new selection, these will be displayed on the appropriate part of the screen. New indicators and controls will be available for the user. The computer will interpret which areas of the display are

active and also what actions to perform for that particular display, and for the selected mode of operation. Operating parameter changes within a given instrument panel will be made when the mode parameters that are adjusted are displayed adjacent to the keys. Due to the multitasking operating system, the graphs dynamically change as the changes occur in real time, just as conventional controls respond. The main display 42 is provided with on-screen graphic capability for displaying graphics objects, such as push buttons, icons, slide bars, etc., representing various functions and parameters. In a preferred embodiment, the microsurgical system 10 has a main display screen with a preferred minimum resolution of 640 x 480 pixels by 16 colors with RGB component control.

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active and also what actions to perform for that particular display, and for the selected mode of operation. Operating parameter changes within a given instrument panel will be made when the user selects the icon for that parameter. When the user makes a selection, the panel will disappear and the screen will return to its previous display, indicating the change made.

As mentioned above in view of Fig. 2 and discussed in greater detail hereinbelow, the hardware modules designed into the microsurgical system 10 provides ultrasound phacoemulsification ("U/S"), bipolar cautery ("cautery"), fiber optic illumination ("fiber optics"), cutting ("cutter"), infusion, vacuum and aspiration ("I/A pumps"). As shown in Fig. 1, multipin connectors 22, 24, 26 and 27 are provided on the front of the main console 14 to enable quick and convenient handpiece connection to the hardware modules intended for use in the system 10. For instance, a connector 22 is the connection for the cautery handpiece (not shown). A connector 24 is the connection for the U/S handpiece (not shown). A connector 26 is the connection for the cutter handpiece (not shown) used for the vitrectomy mode. A connector 27 is the connection for the fiber optic illuminator (not shown). Additionally, a replaceable and disposable infusion/aspiration cassette 28 is provided for controlling the flow of an infusion solution, and the aspiration of this solution from the microsurgical site through a plurality of pinch valves and vent chambers defined within the I/A module disposable cassette.

Fig. 3 illustrates a functional diagram of the remote control unit 16 according to a preferred embodiment of the present invention. The remote control unit 16 has a processor module 112 which includes a processor 112a, flash memory 112b, programmable logic device (PLD) 112c, and DRAM 112d. The processor 112a communicates with any one of the above devices via a processor bus 112e which includes a data bus and an address bus. The processor module 112 receives surgical support function information, such as mode parameters, from a serial communication port

116 which in turn receives the same information, from the main console 14. The processor module 112 continuously monitors all of the buttons mounted on the front panel of the remote control unit 16 to determine whether they have been depressed. The processor module advises the main console 30 whenever a button is pressed. In the preferred embodiment, the processor 112a is a 386 Intel microprocessor. However, any other suitable microprocessor could be used. The software to control the remote control unit 16 resides on either an EPROM or a Flash EPROM, or may be loaded into the remote control unit 16 from a mass storage device, such as a hard disk drive (not shown) or a floppy disk drive (not shown). The controller module 120, which is connected to the processor module 112 through a bus, includes a display controller 120a, RAM-DAC 120b and DRAM 120c. A display controller 120a, such as an SVGA card, is used to drive the display. The RAM-DAC is a video RAM digital to analog converter which converts the digital information from the display controller 120a to an analog signal. The DRAM 120c is a storage medium for storing display data. The data which are converted to an analog signal are fed into the display converter 122. The display converter 122, such as an Analog Devices AD722, converts the SVGA signals to RGB signals needed to drive the display 126. The details of the construction and programming of processor, controller and display converter modules for the control and display of surgical procedure parameters in ophthalmic microsurgical control systems is well known to those skilled in the art.

Fig. 3 also illustrates the video multiplexer 124. In the preferred embodiment, the video multiplexer may be formed by, for example, wiring together the outputs of two AD810 integrated circuit chips to form a 2:1 mux. Additional AD810s may be connected with a proper control circuit to form a higher ratio multiplexer.

The display 126 used with the remote control unit 16 is preferably an LCD display (approximately 6 inches when measured diagonally)

configured to display NTSC (National Television System Committee) video signals from a remote video camera (not shown). A preferred display is a Sharp LQ6NC02 TFT-LCD display, which has a small depth dimension for compact construction of the remote control unit 16, although any other suitable display may be utilized, such as a CRT. The display 126 preferably has a sufficiently high resolution of, for example, 240x234 pixels to clearly display the surgical procedure performed by a surgeon and operational status and functions, including icons and graphs. Alternatively, a display with a smaller diagonal dimension or a lower resolution may be used with the remote control unit 16. Although the remote control display of the illustrated embodiment is described as being used in connection with a video camera, other cameras which are capable of providing image information may be used.

The serial communication port 116 communicates with the processor module 112 in the remote control unit 16 and the processor module 32 in the main console 30 (Fig. 2) using, preferably, the RS-232 communications protocol at a suitable data rate, such as 9600 baud. The serial communication port 16 transfers data corresponding to mode parameters selected from the remote control unit 16 to the main console 30.

The keypad 114 of the remote control unit 16 has a plurality of push button keys arranged in a matrix form with columns used as the driver lines and the rows used as the read lines. The push button keys are driven through a keypad encoder (79C922) which communicates with the process module 112.

Fig. 4 illustrates a functional diagram of the remote control unit 16 according to another embodiment of the present invention. The embodiment in Fig. 4 is identical to that of Fig. 3, except that additional circuits are added to accommodate, for example, different video signal formats used in other countries. For example, the NTSC format is currently used in the U.S.; the PAL (Phase Alternation Line) format is currently used

in certain countries in Europe; and the SECAM (Sequential With Memory) format is currently used in other European countries. The video decoder decodes any one of these video formats and converts them into the NTSC format when an NTSC formatted display is used in the remote control unit 16. A video encoder 134 converts the output from the decoder 132 into a signal useable by the display. If the display is configured to accept differently encoded video signal, such as PAL or SECAM, then a corresponding encoder may be used in place of the NTSC encoder 134.

The remote control unit 16 according to the preferred embodiment of the present invention will be described in conjunction with Fig. 5. The remote control unit 16 is constructed in its own molded plastic housing and is connected to the main control console 14 by a communication cable 18. The communication cable 18 has a connector 151 for connecting with a matching mating connector in the main control console 14. The front surface of the remote control unit 16 includes a large rectangular panel for positioning a display 152, located substantially in the center of the front surface. There is also a plurality of push button switches vertically and horizontally arranged around the display 152, as shown in Fig. 5. For example, there are five pairs of up/down keys 154a-f and 156a-d and eleven push button keys 158a~e, 160a~e and 162. The remote control unit 16 can be mounted on a surgical tray (not shown) with a swerving base (not shown) for easy access by surgical assistants.

Fig. 5 illustrates a front view of the remote control unit 16 displaying the phaco control settings, which is one of the modes supported by the remote control unit 16. In the preferred embodiment, the remote control unit 16 can be used to support such modes as cauterization, phacoemulsification, irrigation/aspiration, vitrectomy, illuminator, etc. In each mode (except where noted), the remote control unit 16 can support such mode parameter changes as vacuum up/down (all modes), flow rate up/down (all modes), ultrasonic power up/down (the phaco mode), pulse

rate up/down (the ultrasonic mode), cut rate up/down (the vitrectomy mode) and cautery power up/down (the cautery mode). In addition, in each mode (except where noted), the remote control unit 16 can support the following surgical support functions: preference select, prime, IV pole up/down, infusion auto/continuous, footswitch fast/normal/slow, pulse control on/off (the phaco mode), and cutter guillotine/rotary/osc, (the vitrectomy mode). Under the preference surgical support function noted above, the remote control unit 16 can support a limited setup option. The functions in this setup option are limited, for example, to (1) selecting a doctor and (2) selecting a doctor preference.

The remote control unit 16 has a plurality of icons displayed thereon which are used to invoke specific tasks. As each task is invoked, the controls associated with that task, and any pre-set operating ranges are displayed on the display. The surgeon or nurse can adjust the preset level by pushing the up and down buttons. During operation, the preset value and the actual value at the instrument are displayed. This type of control and indicator design is consistently applied for all of the surgical modules and all of the surgical functions which have both a preset control value and a monitored actual value which changes in real time. When two modules are invoked at the same time, both sets are displayed on the screen simultaneously, as shown in Fig. 5. Thus, when infusion/aspiration has been invoked, and the surgeon is using a cutting or phaco-emulsification handpiece, both sets of controls and both sets of monitored actual values will be simultaneously displayed.

With regard to the display 152, the remote control unit 16 can display, for example, the mode parameters for cautery power, ultrasonic power, pulse rate, vacuum, flow rate, cuts per minute and intensity. Furthermore, the status information pertaining to a doctor name, mode name, preference name, foot switch position, cassette status, errors/warnings/advisories, and handpiece status (the ultrasonic and the

vitrectomy modes) is displayed on the remote control display 152, as shown in Fig. 5. Preset values 170a and 172a appear on the left side of bar graphs, and the actual power appears to the right in the ultrasonic module control display shown in Fig. 5. The actual values 170c and 172c appear on the right side of the bar graph 170b and 172b, respectively. The width of the bar graphs changes, from left to right, as the actual value changes in real time. This display gives an instantaneous reference point for the actual value versus the preset value. This control/indicator design is consistently applied for all surgical functions having both a preset control value and a monitored actual value which changes in real time.

The function of various switches on the remote control unit 16 will now be discussed by way of an example. As shown in Fig. 5, the remote control unit 16 has a display 152 and push button switches which transmits information to the system 14 by a communication cable 18. The remote control unit 16 has a number of switches on its front panel. For example, the keys 158a-158e correspond to mode selections switches. The keys 160a-160e correspond to surgical support functions on the remote control 16. The keys 154a-154f and 156a-156d correspond to preset level adjustments. The key 162 corresponds to a display selection switch for switching between a video feed from a surgical microscope and operating parameters. The remote control buttons are arranged to correspond to the icons 164a-164e and 168a-168e and legends 166a-166e and 178 shown on the display 152. For example, the key 158a selects the cauterization mode, and thus, is located immediately above the cauterization icon 164a, which is above the cauterization legend 166a.

Pressing the appropriate remote control keys will cause the same responses from the machine as touching the touch screen 46 of the main display 42. The system control and display responses to remote control interaction will be identical to the same touch screen display actions on the main display 42. For example, the phacoemulsifier icon 164b as indicated

in Fig. 5 is selected by depressing the key 158b on the remote control unit 16. The percentage of power transmitted through the amplifier is controlled by the system microprocessor 32 (in Fig. 2) and adjusted by the user by pressing the power up/down control buttons 154a and 154b. The user selected power setting display 170 is shown in Fig. 5 as a bar graph 170b and a numeric display 170a on the display 152. The actual power display indicator 170c displays the real time percentage of maximum power (actual power value) delivered to the handpiece and is shown in Fig. 5 as next to the preset power display bar graph 170b.

When the pulse on/off control icon 168d is selected by depressing the key 160d, the remote display 152 will reveal a numerical pulse display 174 (which ranges from 115 pulses per second). The up/down arrow switches 156a and 156b allow the user selection and adjustment of the pulse rate. As shown in Fig. 5, when selected, the phaco time display 180 indicates the elapsed time in minutes and seconds, (maximum of 99 minutes and 59 seconds).

As mentioned above, the remote control unit of the present invention is designed to provide a graphical user interface ("GUI") for employing various pull-down menus and dialogue boxes on the screen for interaction with a user or operator. Thus, the remote control unit 16 is provided with on screen graphics capability for displaying graphics objects, such as push buttons, icons, slide bars, etc., representing various functions and operating parameters.

Fig. 6 shows the remote control unit 16 with its remote display showing a surgical site, instead of surgical parameters. The surgical view is selected by activating the display selection switch 162. Having the ability to switch the image being viewed back and forth between an image of the surgical site and the surgical control parameters has a number of advantages. For example, because the actual surgical site is typically very brightly illuminated to assist the surgeon, the nurses eyes often have

difficulty adjusting to the lower light levels of the control panel immediately after the nurse views the actual surgical site. Thus, by activating the switch 162 to switch the image being viewed on the display 126 of the remote, back and forth between the surgical site and the surgical control parameters, the light levels to the nurse's eyes remain relatively constant so that the need for the nurse's eyes to adjust after viewing the surgical site is reduced or eliminated. Furthermore, because the surgical assistant has continuous real-time surgical information available, he or she can prepare for the next surgical procedure without relying on the surgeon's verbal instructions. In addition, where in a conventional system, the surgical assistant must separately look at the surgical site, surgical monitor and control system located at various locations around the surgical area, the preferred embodiment of the present invention allows the surgical assistant to observe only the remote control unit 16 which displays and provides all of the necessary information.

As an alternative embodiment of the above described remote control unit, different electronic control circuits may be used within the remote control unit 16 to provide the necessary monitoring and display functions. In addition, different types of switches and displays may be used. Further, either optical or radio communication signals may be used to exchange information between the main control console and the remote control unit. Still further, a display touch screen may be implemented with or instead of the existing display and switches to select surgical modes and functions.

Moreover, the display of the remote control unit may display both the mode function parameters, such as flow rate, and the video feed from the surgical site, instead of switching between the two. Such display may be incorporated as a picture-in-picture or a split screen format.

While the description above refers to particular embodiments of the present invention, it will be understood that many modifications may be made without departing from the spirit thereof. The accompanying claims

are intended to cover such modifications as would fall within the true scope and spirit of the present invention. Moreover, although the above embodiments of the present invention have been described in the context of ophthalmic surgery, the remote control unit 16 may be configured to be used for other types of surgery, such as oral surgery.

The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

WHAT IS CLAIMED IS:

1. A control module for use in combination with a camera adapted to view a surgical site and a surgical control console for controlling surgical procedure parameters, the control module comprising:

a user-operated display selector for selecting for display at least one of the camera view of the surgical site and selected surgical procedure parameters of the control console; and a display apparatus for displaying the display selected by the user-operated display selector.

2. A control module according to claim 1, wherein the user-operated display selector and the display apparatus are housed in a portable enclosure.

3. A control module according to claim 1, further comprising a plurality of switches for inputting control signals to control surgical procedure parameters.

4. A control module according to claim 3, wherein the plurality of switches are positioned around the display apparatus.

5. A control module according to claim 3, wherein the display apparatus displays surgical mode icons in which each surgical mode is selectable with one of the plurality of switches.

6. A control module according to claim 3, wherein the plurality of switches further includes a first group of switches for selecting surgical modes, a second group of switches for selecting surgical support functions, a third group of switches for adjusting operating parameters.

7. A control module according to claim 6, wherein the display apparatus displays surgical mode icons selectable with the first group of switches of the plurality of switches.

8. A control module according to claim 7, wherein the first group of switches is positioned adjacent to the surgical mode icons.

9. A control module according to claim 6, wherein the display apparatus displays surgical support function icons selectable with the second group of switches of the plurality of switches.

10. A control module according to claim 9, wherein the second group of switches is positioned adjacent to the surgical support function icons.

11. A control module according to claim 1, wherein the control module supports cauterization, ultrasonic, irrigation/aspiration, vitrectomy and illuminator modes.

12. A control module according to claim 11, wherein the control module controls vacuum rate and flow rate for ail of the modes, ultrasonic power and pulse rate for the ultrasonic mode, cut rate for the vitrectomy mode, and coagulation power for the coagulation mode.

13. A control module according to claim 11, wherein the control module controls preference select, prime, IV pole, infusion rate, footswitch functions for all of the modes, pulse control function for the ultrasonic mode, and cutter choice function for the vitrectomy mode.

14. A control module according to claim 1, wherein the display apparatus displays at least one of surgical feed back signals including actual infusion flow rate, actual aspiration flow rate, actual cutting rpm, ultrasonic frequency, actual vacuum rate, and intensity.

15. A control module according to claim 1, wherein the display apparatus displays at least one of surgical status information including surgeon's name, mode name, preference name, footswitch position, cassette status, warning, errors, advisories and handpiece status.

16. A control module according to claim 1, further including a multiplexer responsive to the user-operated display selector for selecting for display at least one of the camera view of the surgical site and the selected surgical control parameters of the control console.

17. A control module according to claim 1, further including a processor for electrically receiving information from and sending information to the control console via a communication interface.

18. A remote display control system for use in combination with a video feed from a surgical site and with a surgical control system for ophthalmic surgery, the remote display control system comprising: a keypad having a plurality of switches; a processor for receiving control commands and operating parameters from any one of the keypad and the surgical control system; a display controller connected to the processor to process operating parameters; a video multiplexer connected to the display controller and the video feed, wherein the video multiplexer outputs any one of the operating parameters and the video feed in response to a command signal from the processor; a display apparatus connected to the video multiplexer; and a communication interface coupled to the processor

for sending information to and receiving information from the surgical control system.

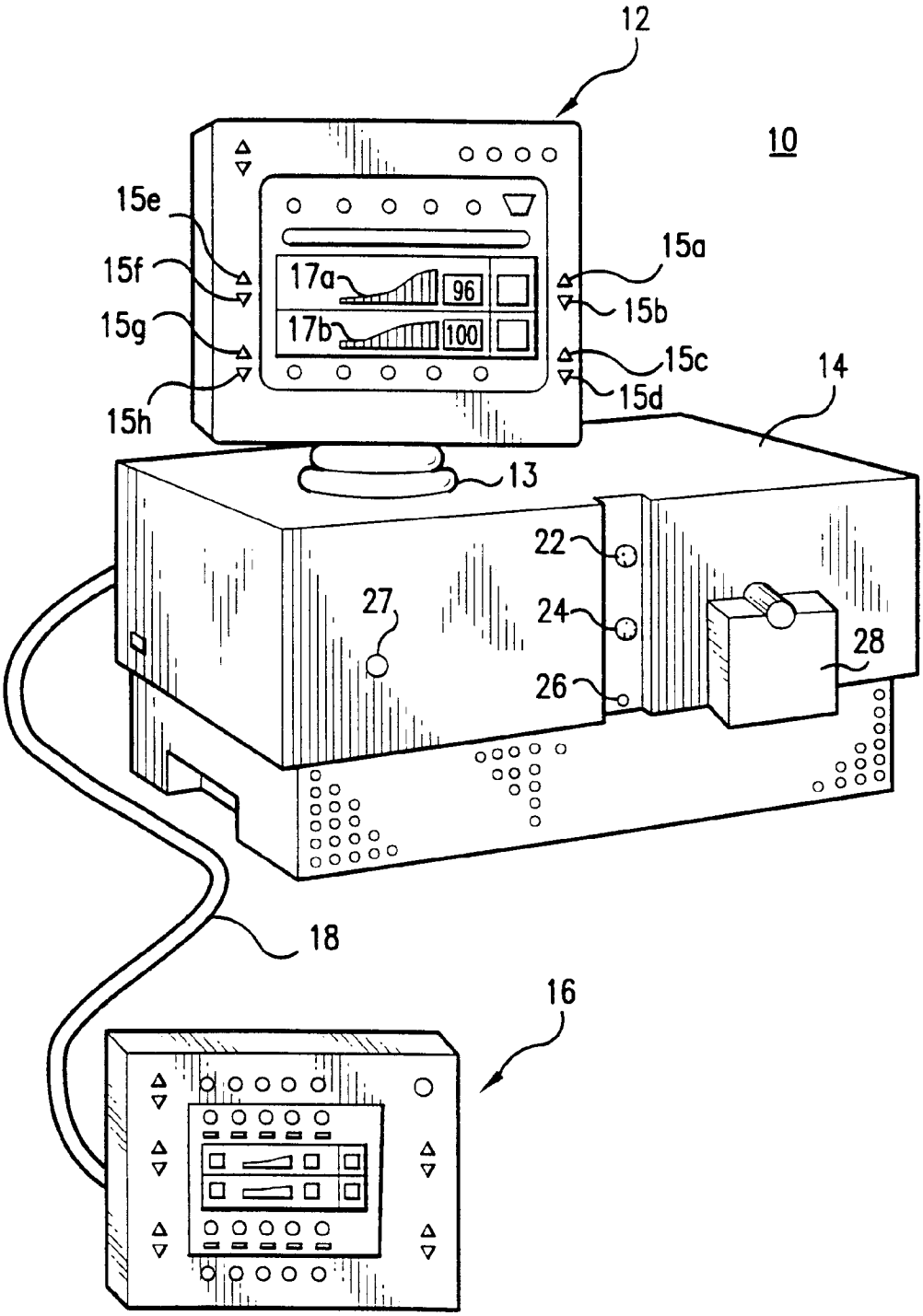
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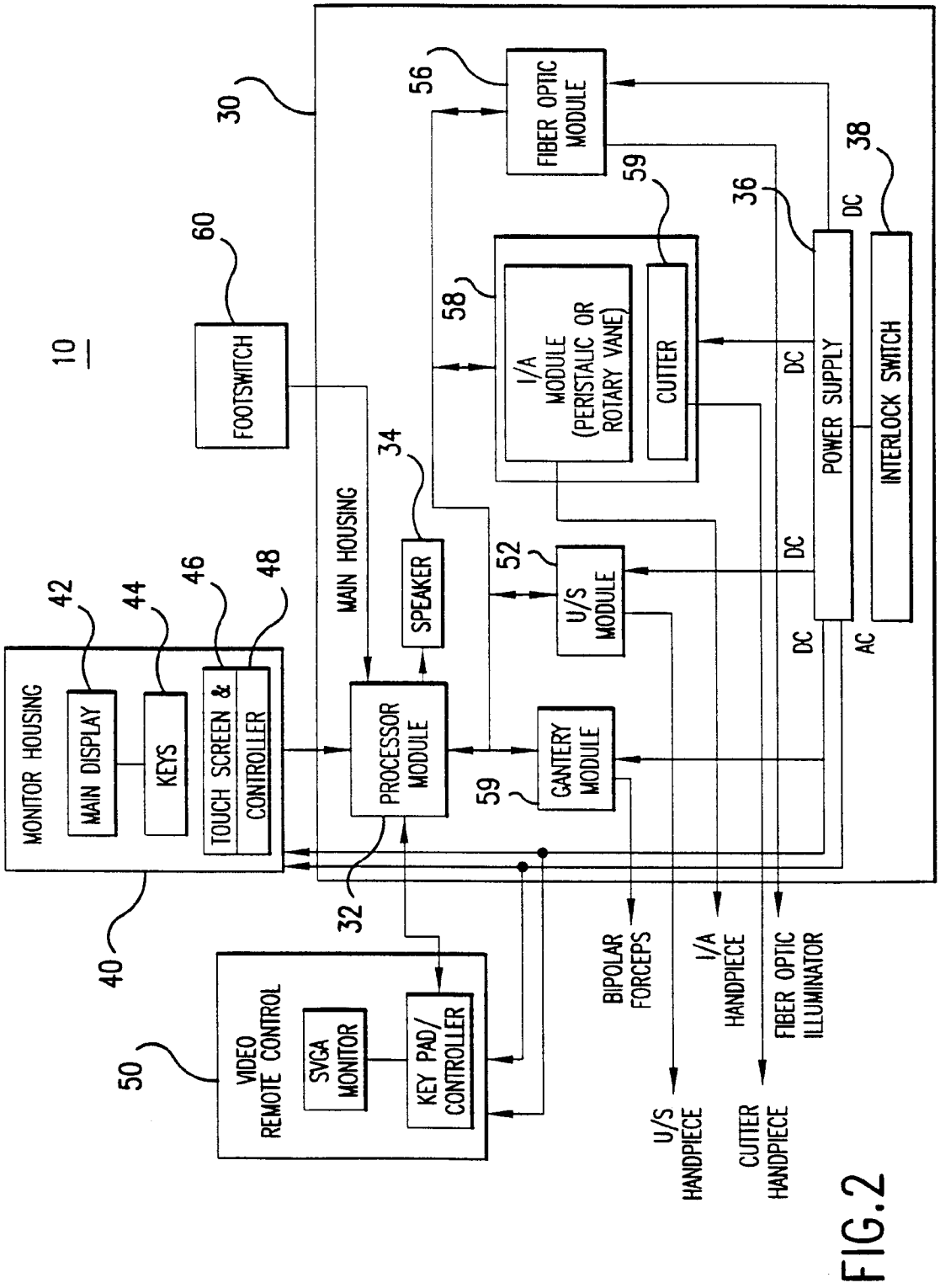
FIG. 1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MONITOR HOUSING
MAIN DISPLAY
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TOUCH SCREEN & CONTROLLER
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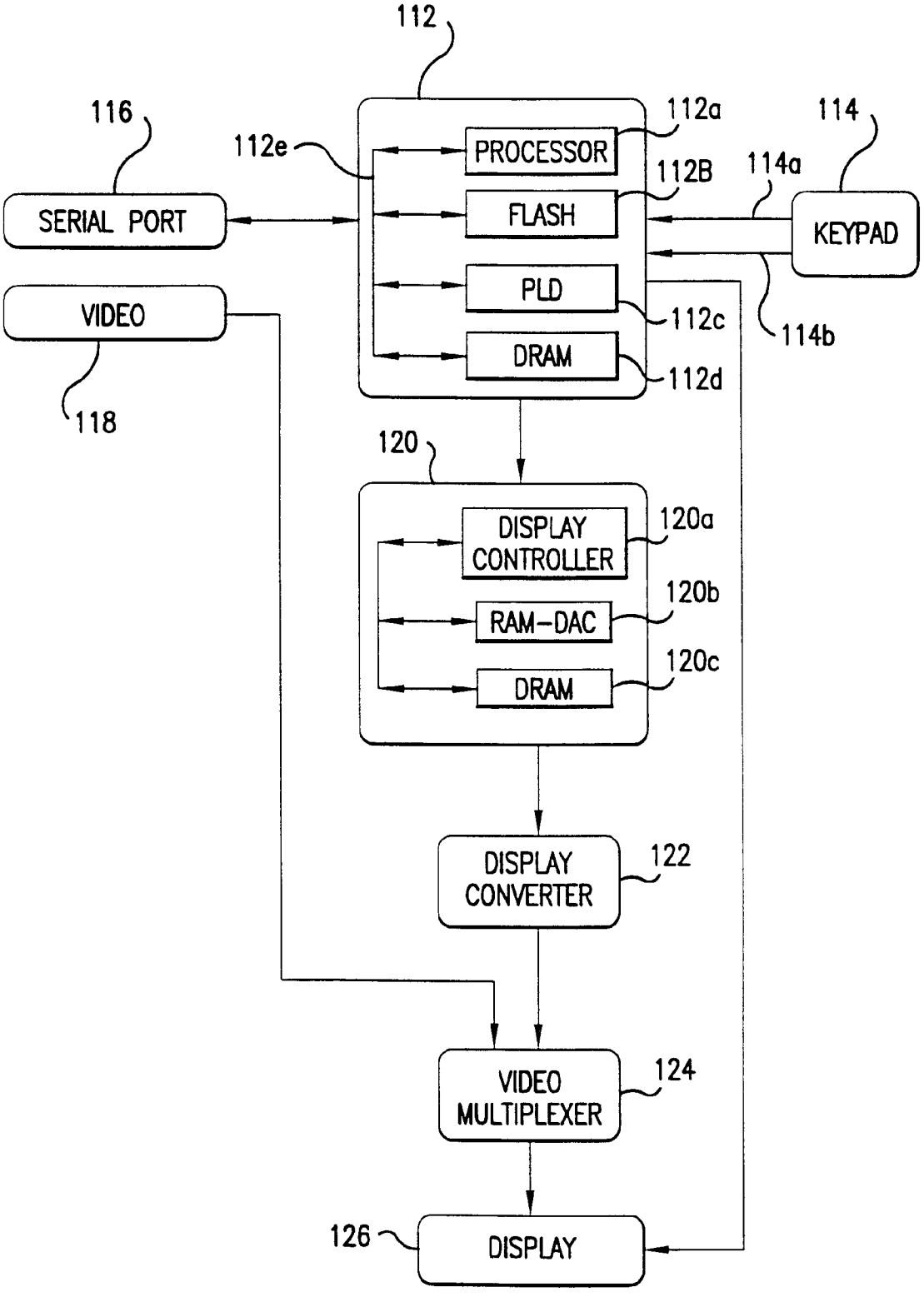
44
46
48
40
PROCESSOR MODULE
32
SPEAKER
34
FOOTSWITCH
60
FIBER OPTIC MODULE
56
I/A MODULE (PERISTALIC OR ROTARY VANE)
58
CUTTER
59
U/S MODULE
52
GANTERY MODULE
59
POWER SUPPLY
36
INTERLOCK SWITCH
38
DC
DC
DC
DC
AC
VIDEO REMOTE CONTROL
50
SVGA MONITOR
KEY PAD/ CONTROLLER
BIPOLAR FORCEPS
I/A HANDPIECE
FIBER OPTIC ILLUMINATOR
U/S HANDPIECE
CUTTER HANDPIECE

FIG.2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112d
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120
DISPLAY CONTROLLER
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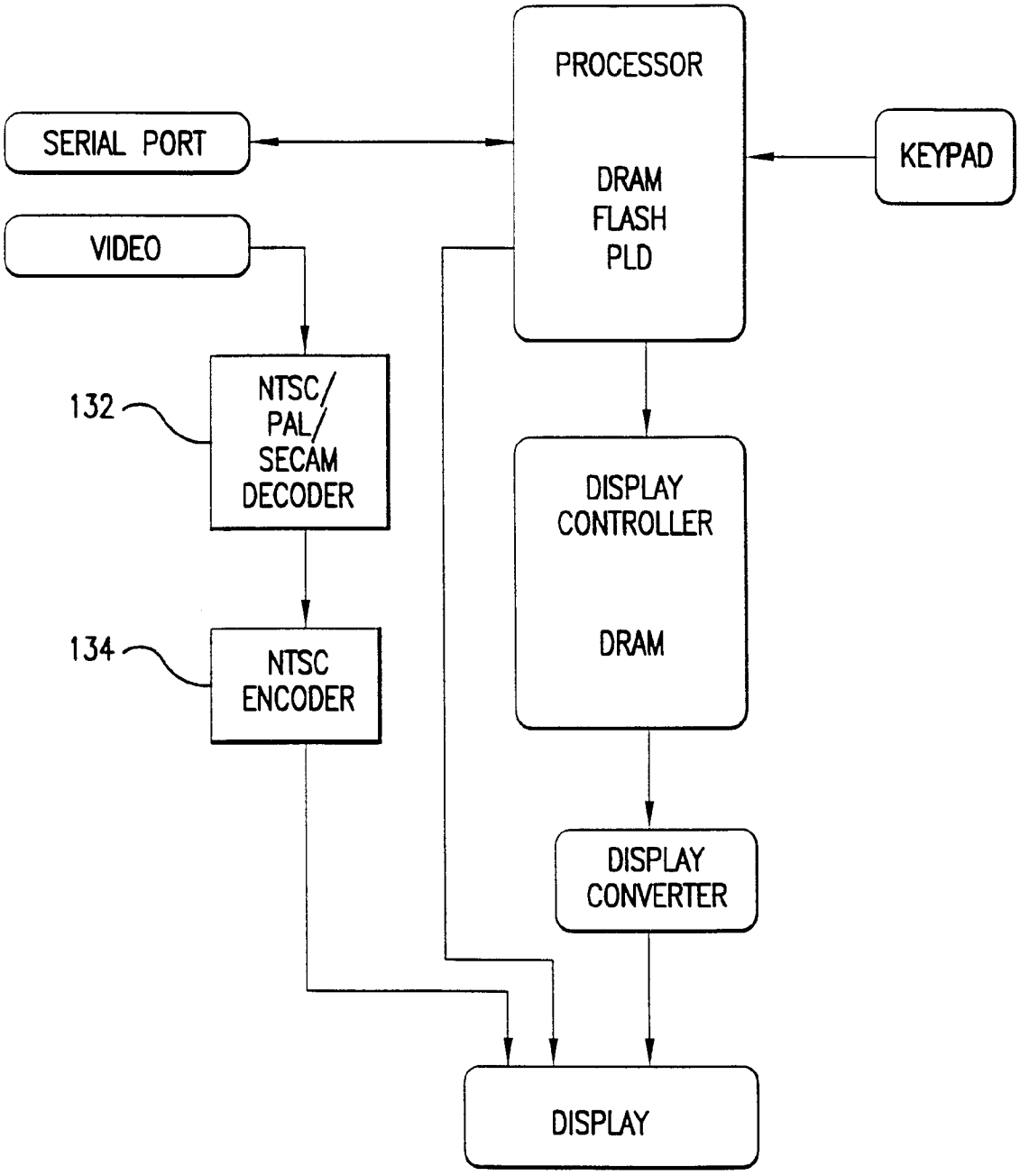
VIDEO MULTIPLEXER
124
126
DISPLAY

FIG.3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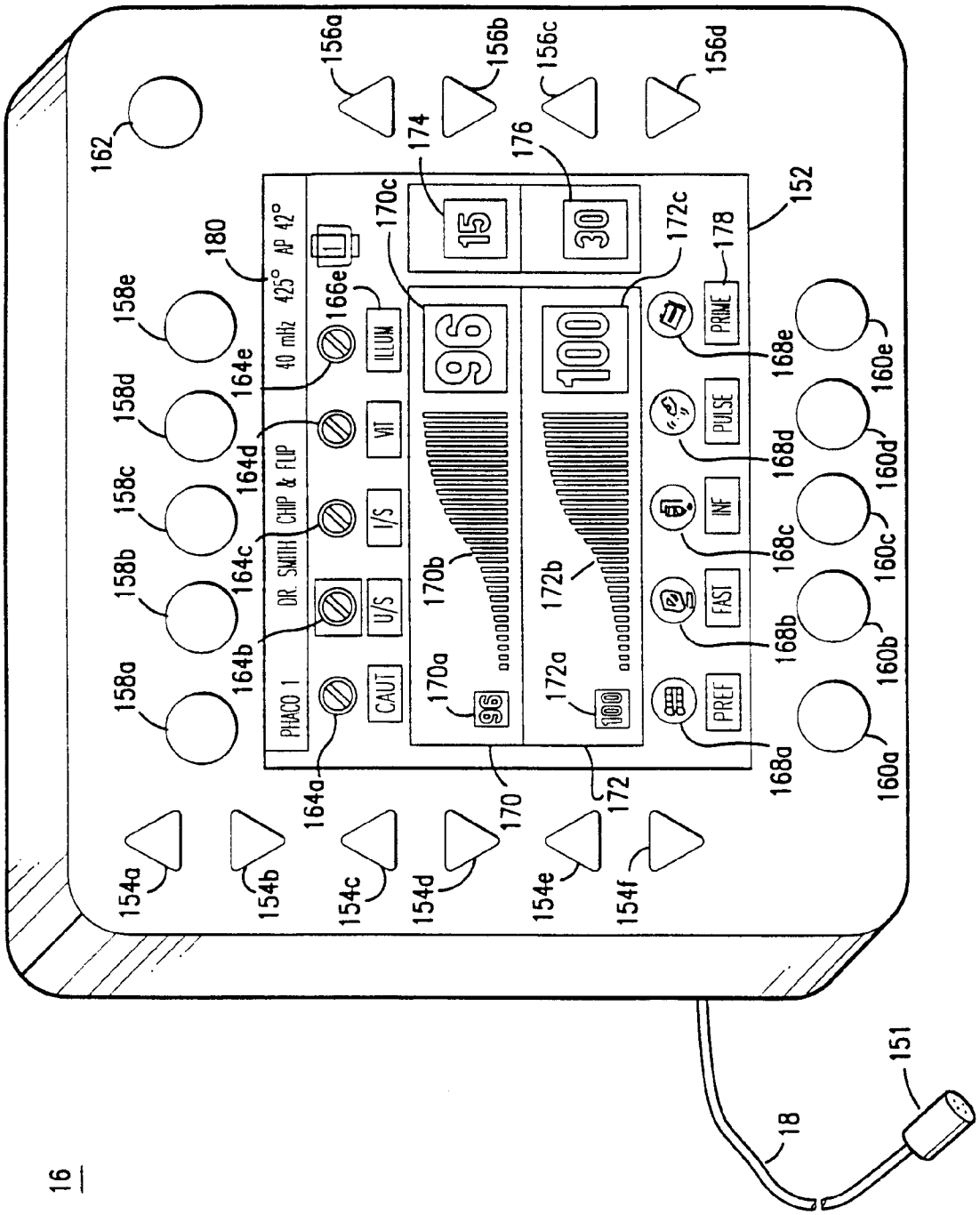
DISPLAY

FIG.4

FIG.5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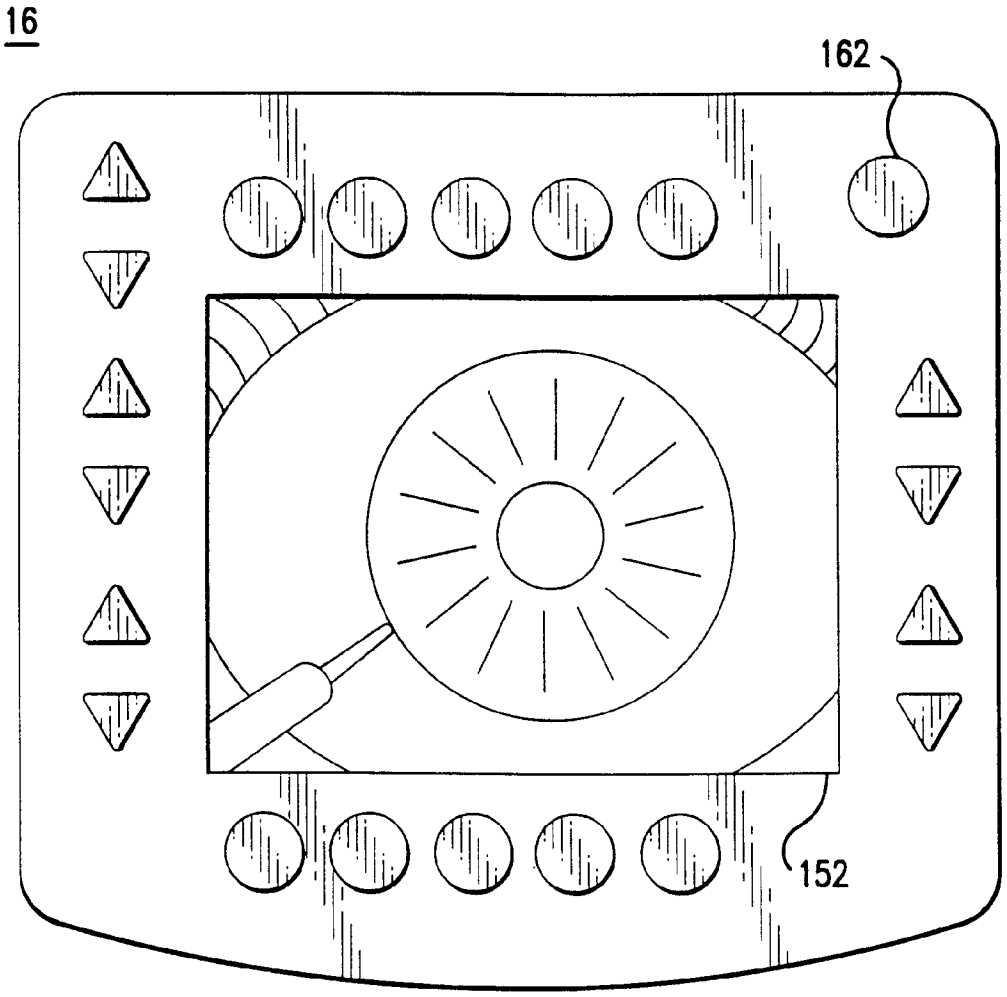

FIG.6

INTERNATIONAL SEARCH REPORT

Intern ional Application No
PCT/US 97/22056

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61F9/00 A61B17/36 A61B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 96 13216 A (CHIRON VISION CORP.) 9 May 1996 see claims	1-18
Y	WO 94 15531 A (THE STATE OF ISRAEL ET AL.) 21 July 1994 see page 11, line 1 - line 6; claims 1-7; figures 3-8	1-18
A	EP 0 424 686 A (STORZ INSTRUMENT CO) 2 May 1991 see the whole document	1,18

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
31 March 1998	06/04/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Raybould, B

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Interr. nal Application No
PCT/US 97/22056

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9613216 A	09-05-96	AU 4006895 A	23-05-96
WO 9415531 A	21-07-94	AU 6266994 A	15-08-94
		EP 0678002 A	25-10-95
		JP 8510393 T	05-11-96
		US 5603328 A	18-02-97
EP 424686 A	02-05-91	JP 3165759 A	17-07-91